

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of

Response Efforts Undertaken During 2017
Hurricane Season

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PS Docket No. 17-344

COMMENTS OF VERIZON

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I. INTRODUCTION

The 2017 hurricane season’s widespread impact on communications networks in the Southeastern United States and the Caribbean provides an important snapshot into the industry’s progress in making networks and services more resilient and reliable in the years since Hurricane Katrina and Superstorm Sandy. It also highlights the importance of disaster coordination and planning across different industry sectors and between industry and government stakeholders. Verizon’s performance during and after Hurricanes Harvey and Irma illustrates the benefits of upfront investment in – and applying best practices to – reliable network infrastructure, personnel training, and other preparedness measures. Due to our substantial investment in network architecture and backup power resources, more than 98 percent of Verizon’s network facilities in the hardest hit areas in Texas remained in service during and after Harvey. In Florida more than 90 percent of our facilities remained operational over the first days after Irma, and within five days after the storm our network performance was back its normal high level. In nearly all the counties for which the Commission activated its Disaster Information Reporting System (“DIRS”) for cell site outages, Verizon’s performance exceeded the industry’s aggregated average.

The Public Notice asks a number of focused questions about the impact of the storms on network architecture, consumers, and service providers, and the Commission's response throughout the events. Verizon below responds to those questions that relate directly to its services or to its first-hand experience primarily during Hurricanes Harvey and Irma. While Verizon is not a facilities-based service provider in Puerto Rico, it worked to support its roaming partners' recovery efforts there, so we offer some more limited observations regarding our experience in that area.

II. EFFECTIVE RESPONSE REQUIRES INVESTMENTS IN RESILIENT AND RELIABLE NETWORKS AND STRONG COOPERATION BETWEEN INDUSTRY AND GOVERNMENT STAKEHOLDERS.

A. Verizon's Investment in Reliable and Resilient Networks and Adherence to Best Practices Prevented or Substantially Mitigated the Storms' Physical Impact (Impacts to Communications Infrastructure).

1. What were the major causes of communications outages due to the hurricanes? Were there unique factors that affected outages and/or resilience during any particular hurricane?

Verizon's wireless network proved very resilient during both Harvey and Irma. The extensive loss of commercial power across wide geographic areas was the principal cause of widespread outages of fiber backhaul networks which, in turn, resulted in outages of commercial wireless networks in many coastal counties in Texas and Florida. In Harvey, flooding was the principal cause of the loss of electrical power and subsequent outages; in Irma, wind damage was the primary cause (though flooding was a significant factor there also). Harvey and Irma thus presented challenges similar to those experienced Hurricane Katrina in 2005 and Superstorm Sandy in 2012, albeit on a different scale. But, as discussed below, Verizon applied the lessons learned in those earlier disasters to our response to Harvey and Irma, to the benefit of consumers,

businesses, and the state and local governments that serve them. As a result, Verizon led the industry's network performance and restoration efforts.

2. What were the cascading effects of communications outages? Did communications service outages have impacts on supervisory control and data acquisition systems (SCADAs) of other critical infrastructure?

Verizon is not aware of any specific SCADA-related impacts. But for our customers that maintain critical infrastructure, several Verizon business practices addressed their needs during Harvey and Irma. These included using dedicated account representatives to maintain ongoing communications with critical infrastructure entities like electric utilities and local government customers. In addition, critical infrastructure entities often protect their services through Telecommunications Service Priority ("TSP") restoration arrangements with Verizon, and for Harvey and Irma Verizon was generally able to resolve new TSP installation orders within a single day. This priority restoration performance shows the importance of critical infrastructure entities' investment in TSP arrangements where possible. And for Hurricane Irma in particular, Verizon coordinated its service maintenance and restoration efforts on an ongoing basis with Florida Power & Light, showing the value of ongoing disaster planning and coordination efforts between the communications and electric utility sectors – which the Commission should continue to promote.

3. To what extent was the communications infrastructure resilient to the hurricanes? What methods were employed prior to hurricane landfall to address infrastructure resiliency?

Verizon's wireless network infrastructure proved extremely resilient during Harvey and Irma, as did its limited facilities presence in Puerto Rico during and after Irma and Maria hit the island.

- *Hurricane Harvey.* As noted, more than 98 percent of our network facilities in the hardest hit areas in Texas remained in service during and after the storm. None of our switching facilities lost service as a result of the storm.
- *Hurricane Irma.* More than 90 percent of our facilities remained operational over the first days after the storm, and within five days after the storm our network performance was back to “business as usual.” As an anecdotal example, once third party backhaul capacity was restored to the Florida Keys after the substantial damage to fiber facilities was repaired, nearly all cell sites became operational immediately. None of our switching facilities lost service as a result of the storm.
- *Hurricane Maria.* Verizon maintains an earth station and accompanying facilities in Puerto Rico for its enterprise communications services that remained operational during and after the storms (Irma and Maria). Verizon installed an antenna designed to withstand high wind at that location, and maintained backup generator and fuel resources throughout the events.

Verizon has implemented a wide variety of methods and practices to achieve this high level of network resiliency during and after hurricane events, many of which are reflected in existing best practices:

- *Siting/Placement.* In addition to basic RF engineering and planning considerations used for all cell sites, Verizon considers the likelihood of hurricanes and other natural disasters in an area to choose the safest, most secure locations for wireless equipment. We install backup generators and batteries at cell sites whenever possible, and at all switching centers, to maintain service when commercial power is lost. In hurricane-prone areas, we install equipment at cell sites on stilts and other elevated platforms. Power, generator, cooling systems and the transport interface are elevated as well, and metal grids protect that equipment from flying debris during severe winds. “Super switches” are built to withstand Category 5 hurricane winds through sound construction methods – tilt wall block construction using concrete and rebar – and with fiber feeds into the building in two distinct locations to ensure additional redundancy.

We also account for the likely increase in wireless demand on hurricane evacuation routes when designing our network capacity. And Verizon complies with applicable building codes, which are typically more stringent on coastal shore sites. Appropriate measures in these areas can include, among other things: foundation and guy wire designs that account for soil conditions and flooding risks, and use of generator shelters fed with commercial power and backhaul fiber through underground conduit.

- *Continuity of Operations/Service Restoration.* Maintaining and restoring service during and after an outage requires investment in and execution of a number of

time-tested practices. Fuel deliveries are pre-arranged, with tankers poised and in position to quickly respond to hard-hit areas to refuel generators. We also maintain a fleet of portable equipment that can be deployed quickly to keep customers connected (e.g. COWs, GOATs, SPOTs, etc.). Verizon had very limited need, however, for temporary transmitter facilities during Harvey and Irma, which shows the resiliency of our physical wireless network infrastructure. A total of just 7 temporary transmitters were used for Harvey and 19 for Irma, even as those events affected 1.8 million and 5 million customers, respectively. This is in part because most outages resulted from the loss of backhaul fiber connectivity. While Verizon could use portable microwave transmitters to support backhaul in some limited circumstances, many of the temporary cell site assets would have been of limited use in those areas where wireline backhaul was lost. Once backhaul connectivity was re-established, however, service was immediately available in most places, underscoring the resiliency of our cell sites.

And Verizon supplemented these tried-and-true measures with new innovative methods. For example, Verizon expanded its use of drones in Harvey to survey cell sites and assess their status, which enabled network technicians to be deployed efficiently to make repairs and restore service. While drones were ultimately not needed for Irma, Verizon engaged in extensive planning and coordination efforts with the FAA, DHS and industry in case they were needed – experience that will carry forward to future disaster events and facilitate the use of drones for mutual aid purposes. And for the first time during these hurricanes, Verizon operated a few portable sites (“SPOTs”) using Ka-band satellite connectivity for backhaul.

4. Are there industry best practices that address communications operations in high risk areas (e.g., flood, high-wind areas)? If so, were these practices implemented and did they prevent and/or mitigate outages? To what extent do these best practices involve cross-industry and/or government participation and was such participation effective?

There are many best practices that directly address communications operations in high risk areas, though many other best practices contribute to network reliability regardless of the particular risk factor.¹ Some of the CSRIC best practices that directly address reliability in high-risk areas include, among others:

¹ See, e.g., CSRIC BP Number 9-7-0435 (“Network Operators, Service Providers, Equipment Suppliers and Property Managers should assess the functions of their organization and identify those critical to ensure network reliability.”); *id.* Number 9-7-0496 (“Network Operators and Property Managers should consider storing their portable generators at critical sites that are not otherwise equipped with stationary generators.”); *id.* Number 9-7-1050 (“Network Operators and

- *CSRIC BP Number 9-7-5214* provides that “Network Operators, Service Providers and Property Managers should consider placing all power and network equipment in a location to increase reliability in case of disaster (e.g., floods, broken water mains, fuel spillage). In storm surge areas, consider placing all power related equipment above the highest predicted or recorded storm surge levels.”
- *CSRIC BP Number 9-9-1067* provides that “Network Operators, Public Safety, Service Providers and Property Managers should consider, in preparation for predicted natural events, placing standby generators on line and verifying proper operation of all subsystems (e.g., ice, snow, flood, hurricanes).”
- *CSRIC BP Number 9-9-5204* provides that “Service Providers, Network Operators, Public Safety and Property Managers should ensure availability of emergency/backup power (e.g., batteries, generators, fuel cells) to maintain critical communications services during times of commercial power failures, including natural and manmade occurrences (e.g., earthquakes, floods, fires, power brown/black outs, terrorism). The emergency/backup power generators should be located onsite, when appropriate.”
- *CSRIC BP Number 9-9-0655* provides that “Network Operators, Service Providers, Property Managers and Public Safety should coordinate hurricane and other disaster restoration work with electrical and other utilities as appropriate.”

In addition to these best practices, Verizon’s commercial wireless network meets the National Public Safety Telecommunications Council guidelines for public safety grade systems in almost every aspect, and exceeds many of them.² These guidelines place a high premium on the reliability of wireless networks and include measures that directly address high wind and flooding events like hurricanes, among other factors. ATIS/NRSC established a “hurricane checklist” after Hurricane Katrina that remains relevant today.³ And CTIA also recently worked collaboratively with local government emergency management stakeholders to formalize a

Service Providers should consider tertiary carrier/transport methods such as satellite, microwave or wireless to further reduce point of failures or as ‘hot transport’ backup facilities.”).

² See National Public Safety Telecommunications Council (NPSTC), *Defining Public Safety Grade Systems and Facilities*, Final Report (May 22, 2014).

³ See ATIS/NRSC, *Hurricane Checklist*, ATIS-0100019 (2006).

number of important practices focused on improving communication between service providers and local government agencies before, during and after disaster events.⁴

Verizon's adherence to these practices (and others) helped to prevent and substantially mitigate outages during Harvey and Irma. By definition, these practices entail cross-industry and cross-sector participation, which proved effective. Verizon coordinated at length with the wireline providers that provide backhaul and other wireline communications that support its wireless services, and with state and local public safety agencies. And, as noted above, Verizon coordinated with electric utilities as needed during the hurricanes, particularly in Florida where Irma had such devastating impact on electric utility infrastructure. In addition, Verizon participates in disaster exercise planning efforts jointly with the electric utility and other participating industries.

B. The Commission's Preparation for and Response to the Hurricane was Diligent, Timely and Thorough (FCC Response).

The Commission's response to the hurricanes was both thorough and measured. Staff were diligent in their focus on maintaining and restoring services to consumers, while also responsive to service providers' needs and sensitive to their strained resources.

1. Are there actions that the FCC could take to improve the support and coordination it provides to industry and government (federal and SLTT) partners? For example, was the FCC support to Emergency Support Function #2 effective?

Commission staff were available and active in their support of federal and state/local recovery efforts, both through the U.S. Department of Homeland Security's NCC-ISAC program and in their proactive support for service providers' efforts to afford interim relief from licensing

⁴ See CTIA, *Best Practices for Enhancing Emergency and Disaster Preparedness and Restoration*, <https://www.ctia.org/docs/default-source/default-document-library/best-practices-for-enhancing-emergency-and-disaster-preparedness-and-restoration.pdf?sfvrsn=0>, at 1-2 (2017).

and other regulatory obstacles that may otherwise have delayed restoration efforts. While many of the resources necessary for service restoration largely remain the responsibility of state and local authorities and other U.S. government agencies like FEMA and the U.S. military, Commission staff are experienced enough with these events to work effectively with the industry and other government stakeholders to achieve that goal. As discussed below, the Commission is also to be commended for its efforts to work constructively with the service providers directly affected by Hurricane Maria to adapt the DIRS process to the unique circumstances of that disaster and ensure that public reports provided to industry, government and media stakeholders offer more relevant information.

2. Are there any actions that the FCC should consider to improve the communications industry response to hurricanes? If so, what would those be?

The most effective action the Commission can take to improve industry response to disasters like hurricanes is to continue its efforts to help facilitate the deployment of next-generation wireless and fiber facilities. Moving new IP-enabled network architecture closer to the end user has the effect of reducing the overall impact of the loss of a given cell site. In many hurricane-affected areas, Verizon's prior efforts to deploy small cells and other diverse network architecture provided an added degree of network redundancy that enabled customers to stay connected to their families and sources of information.

The Commission should also take measures to promote and preserve competition and innovation in broadband communications services for state and local governments and first responders. Verizon was the wireless service provider for many state and local public safety agencies during the disasters who, like consumers generally, benefited from Verizon's reliable network that meets or exceeds nearly all of the public safety grade network requirements as defined by the NPSTC. Public safety users of commercial wireless networks will increasingly

demand robust and dynamic prioritization and preemption capabilities during disaster events, and the Commission's flexible approach to mobile broadband services has enabled the marketplace to respond accordingly without regulatory obstacles.⁵ The deployment of FirstNet's new public safety broadband network is another step forward in this area, but its potential to harness market forces for the benefit of state and local government first responders will be limited if those users cannot benefit from full network interoperability between FirstNet and other public safety communications networks. The Commission should maintain its flexible regulatory policies that enable service providers to offer innovative broadband services to public safety and, together with NTIA, work to promote interoperability across public safety communications networks.

3. *The FCC provided information to the industry and the public before and during the course of hurricane season. For example, the FCC released public notices providing information, including but not limited to, emergency contact information for the FCC's 24/7 center and process guidance on seeking waivers/STAs. The FCC also created event-specific webpages to share information such as communications status reports, public notices, and orders. Was this information helpful? Is there additional information or assistance that the FCC should provide at the beginning or during an event?*

The Commission should continue its policy of proactively informing service providers of the resources and potential regulatory relief available to service providers through Public Notices and Orders. Verizon circulates this information in advance of and during the hurricanes to relevant personnel as a matter of course in our continuity of operations and service restoration efforts. Commission staff also affirmatively reached out to Verizon to check on the status of its earth station facility in Puerto Rico, underscoring the comprehensive nature of the Commission's efforts. While Verizon did not need to avail itself of any waivers or STA requests for Harvey

⁵ See, e.g., *Verizon to build dedicated network core for public safety*, <http://www.verizon.com/about/news/verizon-build-dedicated-network-core-public-safety> (Aug. 16, 2017).

and Irma, Commission staff instantly granted Verizon the needed Special Temporary Authority to operate in Puerto Rico as part of our efforts to support a roaming partner on the island. The staff's quick work demonstrated the Commission's leadership and dedication to helping the storm-ravaged areas in any way possible. Finally, the status reports posted on the Commission's event-specific webpages enable Verizon to compare its own experience and observations in the field with a more "macro" level view of the situation facing service providers in different storm-affected counties and across the industry.

4. How effective were the FCC's responses with respect to RFIs, RFAs, and requests for STAs and waiver requests? Do the processes for handling these requests need improvement and, if so, how can they best be improved?

The Commission responded very effectively in response to Verizon's Special Temporary Authority request. As noted above, Verizon requested and was expeditiously granted Special Temporary Authority to operate wireless facilities in Puerto Rico in support of one of our roaming partners on the island. The Commission's instant grant enabled Verizon, in close coordination with its roaming partner Open Mobile, to use Band 13 spectrum to deploy femtocell facilities at emergency operations centers which, in turn, helped to expedite the availability to reliable data service for our subscribers and other users of Open Mobile's network on the island.

5. To what extent did the data provided by DIRS aid response efforts? Is there additional information, including licensee information, which would improve response and coordination efforts?

As noted above, the Commission's DIRS-related status reports enabled Verizon to compare its own experience and observations in the field with the aggregate experiences of other service providers. While Verizon's monitoring systems provided the company with a comprehensive insight into the affected geographic areas and service impacts of any given outage, this additional aggregated information provided the added benefit of affirming where

service restoration challenges were widespread across service providers and not specific to Verizon, and of providing some comparative benchmarks that Verizon (and all service providers) can use internally as an incentive to improve network reliability even more in future events. In this important respect, the CTIA Wireless Reliability Framework's DIRS reporting commitment has had the desired effect of using competitive marketplace to drive network reliability across the industry.

7. *The FCC provides assistance to industry, first responders, and others in coordinating ad hoc emergency uses of spectrum in the affected areas. To what extent was the coordination process effective?*

See the response to Section II.B.3 above describing the Commission's timely assistance in obtaining Special Temporary Authority to enable it to deploy a femtocell solution in Puerto Rico.

C. *Consumers, Enterprise and Government Service Users All Benefited from Verizon's Investments in Network Reliability (Service User Experience)*

1. *To what extent did government agencies issue emergency alerts to the public, particularly over the Emergency Alert System (EAS) and the Wireless Emergency Alerts (WEA)? What other alerting methods were used? Were those communications effective? For example, were the alerts easy to understand, read, and geographically accurate? Were they accessible to people with disabilities and sent in languages other than English? Were there consumers that the alerts did not or could not reach? If public safety officials chose not to use EAS or WEA, why not?*

Alert Originators, principally the National Weather Service and a number of local authorities, sent hundreds of Wireless Emergency Alerts related to Harvey and Irma. Lessons learned from Alert Originators for these disaster events could be helpful for service providers and public safety alike to ensure that WEAs are used effectively in the future. For example, knowing the type of alerts for which Alert Originators would have used a clickable embedded reference could be helpful to service providers' efforts to manage potential spikes in data usage on their networks in response to (and preparation for) disaster events. In addition, knowing how

Alert Originators were able to use the geo-targeting capabilities available today might help public safety establish some best practices for using both current and future geo-targeting capabilities, including when a narrowly-targeted alert is warranted over a broader county- or statewide alert. A preliminary review of the alerts indicates that curfew, evacuation, hurricane and strong wind alerts were delivered on a county-wide basis, while tornado and flash flood alerts were more narrowly targeted through polygons. Verizon looks forward to reviewing the input from Alert Originators in this regard. Finally, state and local governments in storm-affected areas, including Harris County, Texas (at www.readyharris.org) and the State of Florida (at www.floridadisaster.org) used social media extensively during the storms. While social media obviously serves a different purpose than WEAs, it can be a useful part of a state or local government's "toolbox" of consumer information resources.

2. Were consumers able to effectively reach 911 services via voice and/or text (where text-to 911 was available) during and after the hurricanes? If not, why not? Are there actions that the FCC should take to improve 911 resiliency and reliability during events such as the hurricanes?

While general wireless network outages that Verizon experienced would have prevented consumers from accessing wireless networks for non-emergency and emergency calls alike, Verizon had no 911-specific reliability or outage issues for its wireless network during either Harvey or Irma. Nonetheless, by supporting the reliability of and access to originating service provider networks generally, Commission and industry efforts to support improvements resiliency and reliability for wireless and wireline communications networks would improve wireless users' access to 911 during disasters. In addition, the storm forced a number of PSAPs to temporarily cease operations, showing the importance of establishing alternate routing arrangements where possible and, in the longer term, the potential benefit of more nimble IP-enabled NG911 networks.

3. *Were emergency communications services available to people with disabilities and others with specific communications needs? What actions can be taken to improve emergency communications for these communities?*

Implementation of text-to-911 services has been one of the most important Commission efforts to support access to emergency services for individuals with disabilities. Fortunately, many of the hardest hit jurisdictions in Texas, Louisiana and Florida have deployed text-to-911 service. These include PSAPs throughout Aransas, Galveston, Harris and Refugio Counties in Texas, Lake Charles in Louisiana, and Collier County and Sarasota in Florida. Many other jurisdictions affected by the storm, however, have not implemented text-to-911, and the Commission should continue to encourage state and local authorities to take this important action.

4. *Were consumer complaints related to communications outages responded to by service providers in an appropriate and expedited manner? Is there any action that the FCC should take to improve this process?*

Consumer complaints or inquiries regarding the availability of wireless service during Harvey and Irma would have been fielded through different channels at Verizon, including customer care calls and our retail stores. Our monitoring systems and alarms, however, will have detected a service outage before complaints are received, and were and must remain the principal trigger for addressing service outages through formal “trouble tickets.” Nonetheless, customer care representatives are notified when an outage occurs in a particular area and, to the extent possible, will inform customers that Verizon is aware of the outage and working to fix it.

6. *To what extent were first responders able to use their own wireless communications networks and devices? If not, what alternatives were used, if any? What was their experience with land mobile radio and microwave radio services in each hurricane?*

First responder agencies that are customers of Verizon experienced the same network reliability enjoyed by all Verizon customers. In addition, in Texas and Florida we delivered

more than 7,800 mobile devices and other equipment, including smartphones, tablets, routers, jetpacks, battery packs, and charges, to first responders, government organizations and relief organizations. And as noted earlier, Verizon's account representatives worked closely with state and local government agency customers to meet their needs.

7. *The FCC oversees the National Security/Emergency Preparedness (NSEP) priority service programs, which provide for service restoration and provisioning and mobile wireless and wireline priority. To what extent were the priority service programs effective? Did NSEP users receive improved performance (higher percentage of call completion) when using the Government Emergency Telecommunication Service (GETS) and Wireless Priority Services (WPS) compared to non-prioritized voice calls? If not, why not? Were GETS calling cards distributed across emergency responder organizations? Were emergency responder cell phones equipped with WPS? Are there any actions that the FCC could take to improve the effective use of the priority services programs?*

Verizon's participation in the NSEP priority service programs was effective. As noted earlier, Verizon was able to respond to TSP service restoration requests expeditiously. Verizon also participates in both GETS and WPS programs, which NS/EP entities used extensively during the storms. GETS and WPS were operational and available to first responder customers coextensively with the availability of Verizon's wireless service generally. To preserve the effectiveness of GETS and WPS programs, which will be expanded to voice and data services offered over LTE in the near future, the Commission should maintain its flexible approach to mobile broadband services so that service providers can timely meet first responder and other NS/EP service needs.

D. Verizon's Network Reliability Practices Enabled it to Maintain and Quickly Restore Service (Communications Provider Experience).

1. *To what extent were service providers able to pre-position equipment, supplies, and/or resources close to the affected areas in advance of each hurricane? How did this impact the continued availability of communications services or facilitate recovery?*

Verizon was generally able to pre-position resources on a timely basis in close enough proximity to the affected areas. State and local governments were also supportive of our efforts to establish staging areas for these assets. As noted above, though, with limited exceptions Verizon was able to maintain service to customers due to overlapping cell site coverage and rely on on-site generators, and as a result did not need to rely on pre-positioned transmitter resources extensively. Nevertheless, industry and public safety coordination on establishing staging areas for resources remains a critical to disaster planning and recovery, and for that reason is a prominent component of the best practices that industry recently established with input from local government stakeholders.⁶

3. *Was radio frequency information shared among service providers? Were there instances of interference and were they resolved in a timely and effective manner?*

Despite their extensive impact on wireless networks, Harvey and Irma did not pose a need for Verizon to share radiofrequency information. Verizon is also unaware of any instances of interference with other service providers in the areas affected by Harvey and Irma. Verizon engaged in the coordination efforts with other licensees necessary to support the grant of its STA request for Puerto Rico, which were resolved in a timely and effective manner.

4. *How could DIRS notices sent to participating communications providers during the storms be improved? Were there any problems/issues in reporting outage information into DIRS? Should DIRS be modified to improve user experience, and if so, how?*

Verizon had no problems with either Bureau staff's delivery of DIRS notices or completing and timely filing DIRS reports. In the future, it may be possible to simplify the

⁶ See CTIA, *Best Practices for Enhancing Emergency and Disaster Preparedness and Restoration*, <https://www.ctia.org/docs/default-source/default-document-library/best-practices-for-enhancing-emergency-and-disaster-preparedness-and-restoration.pdf?sfvrsn=0>, at 1-2 (2017).

DIRS format. For example, the list of counties subject to the DIRS reports remained static throughout an event, even after the DIRS activation was lifted for a particular state or county. Updating the list of reportable counties as a disaster progresses could make the filings more user-friendly and less confusing as service providers bring in new shifts of technicians during a long-running disaster event – but this was a minor, manageable issue. Verizon also recommends that discussions continue between industry and Bureau staff regarding the unique issues that Maria posed for the usefulness of DIRS-related information. The magnitude of the circumstances facing service providers and government agencies in Puerto Rico are unique, and it may be appropriate to modify the DIRS process when disaster events present extreme circumstances.

5. *What were the most effective means to restore connectivity to the communications infrastructure (e.g. backhaul, last mile) and how long did it take to do so?*

Where backhaul was out solely due to the loss of commercial power in Harvey and Irma, service restoration largely depended on the ability to provide and maintain backup power. In most cases that took 1-2 days after the event, but in some cases it took longer because flooding, downed trees, or other factors prevented service providers from transporting fuel, generators and technicians to the sites. Where there was significant physical damage to other providers' backhaul connections, service restoration largely depended on the provider's access to the sites. In most cases that also took 1-2 days after the event, but in extreme cases took several days, as was the case for wireless service in the Florida Keys.

6. *Were communications services, such as satellite services, mobile ad-hoc networks, Wi-Fi services, mesh-based communications architectures, experimental projects or other services/technologies used and effective in providing connectivity when other services were limited or down? Should the FCC encourage inclusion of these services in future mitigation plans?*

As noted above, Verizon coordinated with Open Mobile in Puerto Rico to deploy femtocells on Open Mobile's spectrum in and around the island's Emergency Operations Center. Verizon also used this femtocell technology on a limited basis in Florida after Irma. The femtocells used a satellite connection for backhaul. Verizon also deployed portable cell sites to five locations in Florida that used a satellite connection. While these approaches were limited in geographic scope and application, they demonstrate the potential scenarios in which wireless providers could use satellite backhaul in future events.

7. *Were service providers able to route 911 calls effectively to PSAPs or alternate numbers permitted under the rules?*

Verizon experienced no problems in routing wireless 911 calls effectively to PSAPs or, where PSAPs lost service, to the PSAPs' desired alternate fallback method. As the Commission is aware, PSAPs handle these issues differently. Some PSAPs directed wireless providers to route 911 calls to an alternate or default PSAP location when the principal PSAP network is out of service, while others direct wireless providers to route 911 calls to a "fast busy" or similar method in those circumstances.⁷ And some PSAPs affirmatively provided Verizon with this information in advance of the storms to ensure it was current.

8. *What were the obstacles to rapidly restoring communications systems? To what extent did these impediments impact and/or extend the duration of outages? Were FCC efforts to address the impediments helpful?*

The principal obstacles to rapidly restoring communications systems after Harvey and Irma that extended the duration of outages were the storms' impact to other infrastructure such as roads and the electricity grid that prevented service providers from timely accessing the affected

⁷ See, e.g., FCC PSHSB, *Communications Status Report for Areas Impacted by Tropical Storm Harvey*, at 2 (Aug. 27, 2017) (describing affected PSAPs and extent to which a re-route was available to each).

areas. In extreme cases, for understandable safety and security reasons service providers had to wait until state and local government personnel could return to an affected area, as the storms were so severe that critical services like police, fire and rescue had to evacuate as well. While the Commission has limited ability to address those impediments, it can play an important role in highlighting for other stakeholders when and where challenges to service restoration result from factors outside of the control or impact of the communications industry. Chairman Pai's and Bureau staff's engagement in the Federal government's recovery efforts, particularly in Puerto Rico, showed the importance of this role.

9. Were there challenges with the use of back-up power for network equipment? Are there ways to improve the ability of communications infrastructure to operate when commercial power is lost?

Challenges to the use of back-up power resources in Harvey and Irma primarily relate to the wide geographic impact of the storms. Verizon maintains backup generators and battery resources at most cell sites but because of the storms' wide impact, Verizon expended considerable resources transporting portable generators and fuel to the sites that needed it. In Harvey, Verizon trucked in almost 80,000 gallons of fuel and used 11 portable generators. For Irma, Verizon trucked in 490,000 gallons of fuel and used 209 fuel trucks for over 100 mobile generators for that purpose. Verizon's success in maintaining or quickly restoring wireless service shows that the most straightforward way to improve the ability to operate when commercial power is lost remains adequate upfront investment in backup power resources such as generators, batteries and the maintenance thereof. Nonetheless, Verizon is hopeful that its experience in using satellite-based backhaul services can help address circumstances where backhaul provided by third party wireline service providers is not available due to commercial

power loss, particularly for services provided to first responders and other critical infrastructure entities.

10. To what extent was the Wireless Resiliency Framework and each of its elements, i.e. providing reasonable roaming under disaster agreements, providing mutual aid to carriers, enhancing municipal preparedness, increasing consumer readiness, and posting data in DIRS, effective in each hurricane-impacted area? Were there examples of positive impacts and/or deficiencies in the utilization of the Framework, and, if so, what should be improved?

The Wireless Resiliency Framework to date has served consumers, state and local governments and service providers well through its flexible and practicable approach:

- **Roaming Under Disasters.** In Harvey and Irma, Verizon's existing automatic roaming agreements enabled other carriers' customers to roam onto our network in those disaster-affected areas. The impact of the events on roaming traffic varied between markets. And there was more need and demand for disaster-specific roaming arrangements in Puerto Rico and the U.S. Virgin Islands after Maria, particularly for LTE networks. While Verizon is not a facilities-based service provider in those areas, the experience of facilities-based providers in putting those arrangements together in the wake of the storm will be helpful to the broader industry for future disaster events. As Verizon has emphasized in discussions with Commission staff and other policymakers, disaster-related roaming will be most effective when interested service providers enter into those arrangements in advance of a disaster event.
- **Mutual Aid.** In Verizon's experience, wireless and wireline carriers alike worked well together on operational activities during the storms. The DHS National Coordinating Center (NCC) plays a particularly important role in this regard.
- **Enhancing Municipal Preparedness.** A principal focus of the best practices that the wireless industry adopted in December, with important input from local government stakeholders, is establishing channels and points of contact between local governments and service providers before, during and after disasters. The practices largely formalize what service providers and local governments endeavor to do in any event. Another important observation relating to Harvey and Irma is the continued important role that state governments will continue to play in coordinating and supporting local government preparedness and recovery efforts. The statewide emergency management agencies in Texas and Florida both played key roles in facilitating communication between the local governments they serve and the industry.
- **Educating Consumers.** Verizon and the industry more broadly engaged in a number of efforts to remind consumers of measures they can take to ensure they

are as prepared as possible for a hurricane.⁸ These releases are distributed to key media (both national and local) through traditional channels and shared on social media.

- **DIRS.** See the discussion at Section II.B.5 above describing the benefits of the Commission's DIRS-related status website status postings.

11. Does the market and/or government, currently offer sufficient incentives to encourage the build-out and maintenance of resilient communications infrastructure? Are there actions that the FCC should take to encourage industry to build and maintain a resilient communications infrastructure?

Verizon's experience in Harvey and Irma shows that the need to best serve customers offers strong, sufficient incentives to encourage the build-out and maintenance of resilient communications infrastructure. Competitive forces create incentives for service providers to drive innovation and invest in infrastructure that provides the most reliable service possible to their customers, including consumers, businesses, first responders and other government agencies. Going forward, the Commission should continue to facilitate this innovation and investment by continuing to promote competition, making additional spectrum resources available, and simplifying regulations (e.g., facilities siting) where it has authority to do so.

III. CONCLUSION

The performance of Verizon's network during last year's hurricanes shows the benefits of Verizon's ongoing and massive investment in network reliability, while also underscoring the importance of industry and cross-sector coordination. As always, Verizon will assess its

⁸ See <http://www.verizon.com/about/news/staying-connected-during-hurricane-irma-6-tips> (Sept. 6, 2017) (Irma); <http://www.verizon.com/about/news/hurricane-prep-tips-small-businesses> (Sept. 7, 2017) (Irma); <http://www.verizon.com/about/news/verizon-ready-hurricane-harvey-threatens-texas> (Aug. 25, 2017) (Harvey).

performance during the storms and apply the lessons learned to future network reliability and resiliency practices.

Respectfully submitted,

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